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(54) **LIQUID CRYSTAL DISPLAY APPARATUS
AND METHOD FOR GROUNDING LIQUID
CRYSTAL DISPLAY APPARATUS**

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G02F 1/1333 (2006.01)

(52) **U.S. Cl.** **349/58**

(58) **Field of Classification Search** 349/58
See application file for complete search history.

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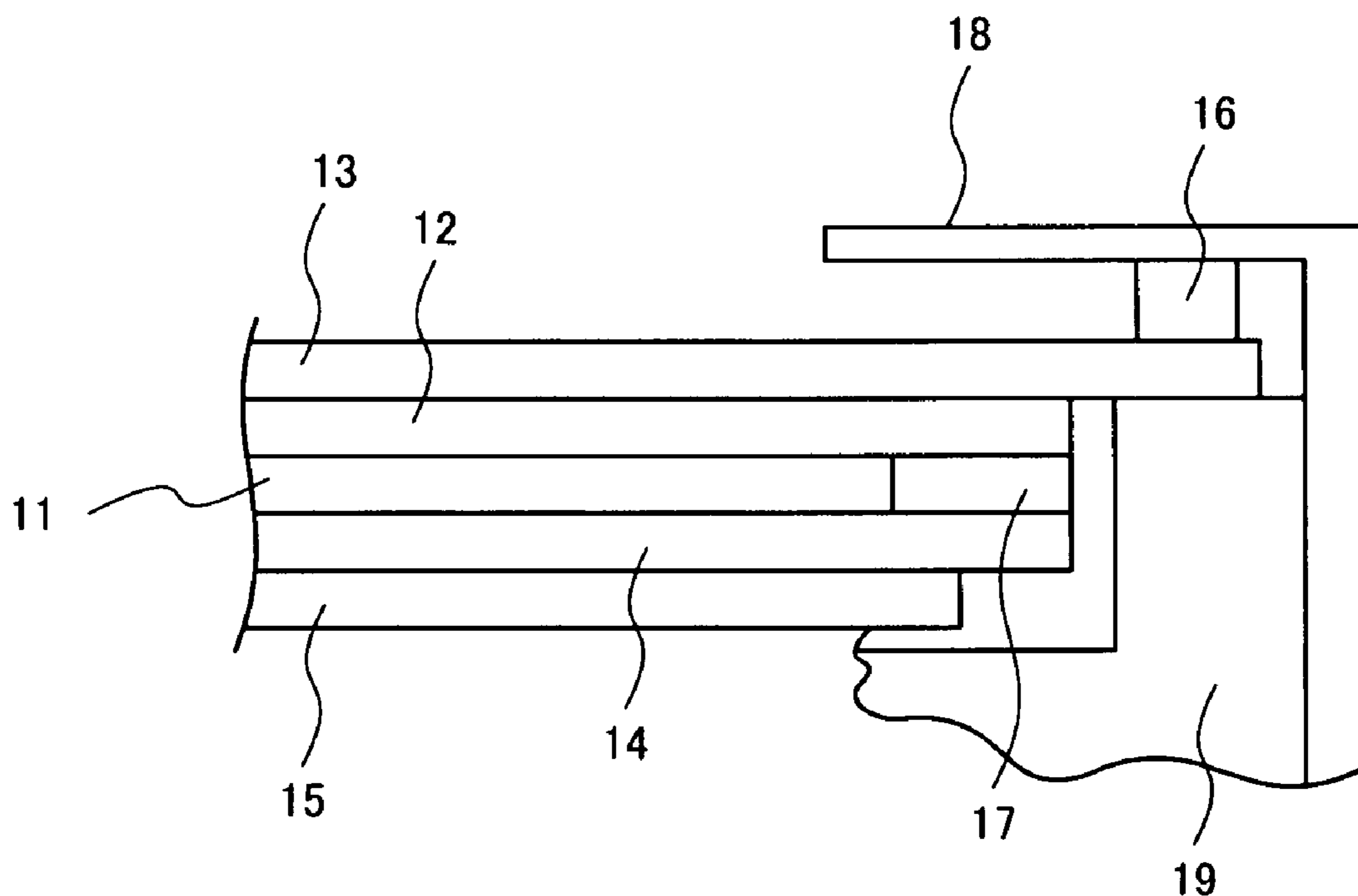
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(57) **ABSTRACT**

Disclosed is a liquid crystal display apparatus, including: a liquid crystal display panel; a polarizing plate which is processed to be conductive and is attached to a surface of the liquid crystal display panel; and a conductive frame, wherein the polarizing plate includes a projecting area which projects outward from the edge of the liquid crystal display panel, and wherein the conductive frame presses the projecting area of the polarizing plate in order to ground the polarizing plate. A method for grounding a liquid crystal display apparatus is also disclosed.

20 Claims, 4 Drawing Sheets



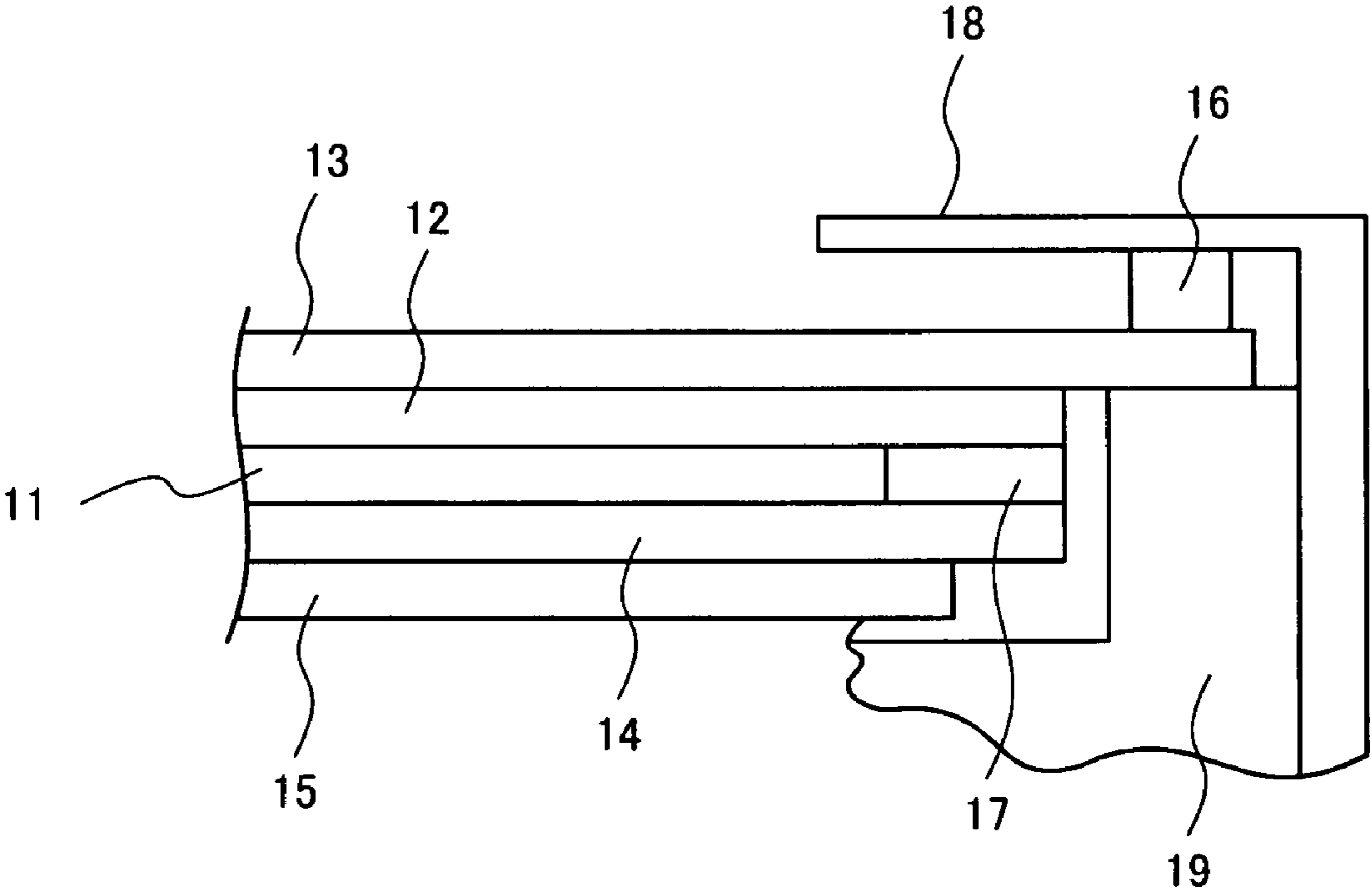


Fig. 1

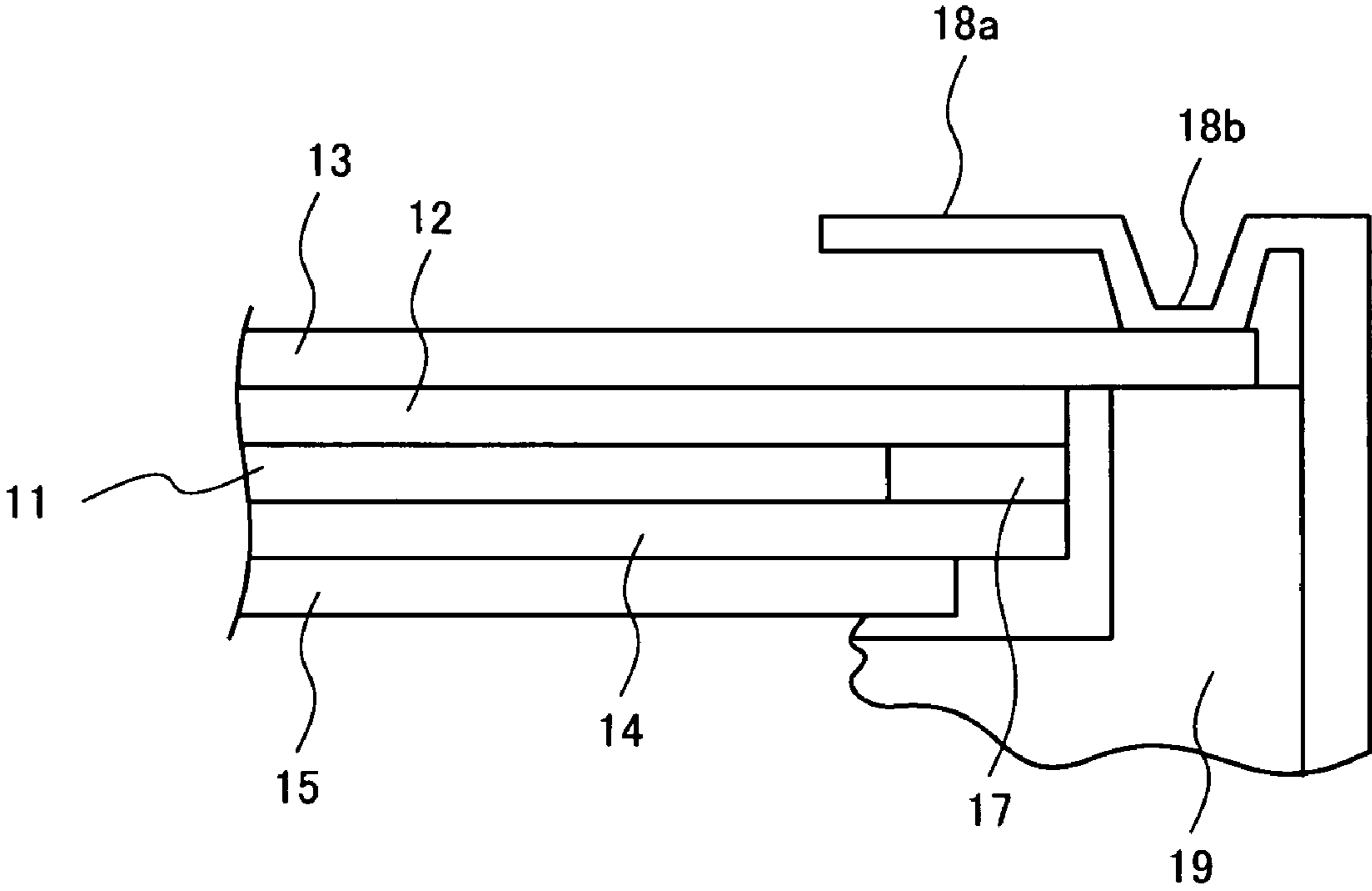


Fig. 2

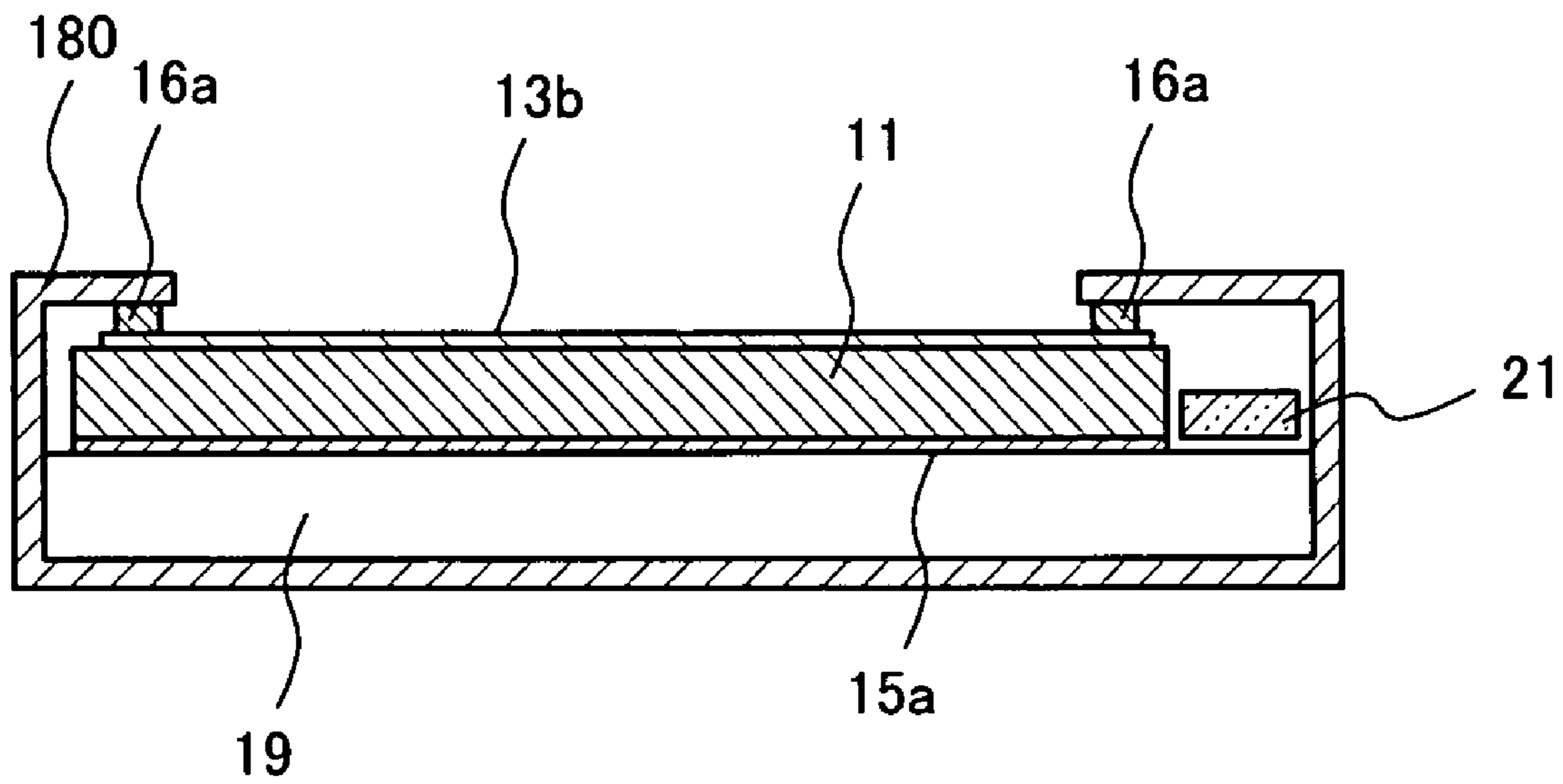


Fig.3
(RELATED ART)

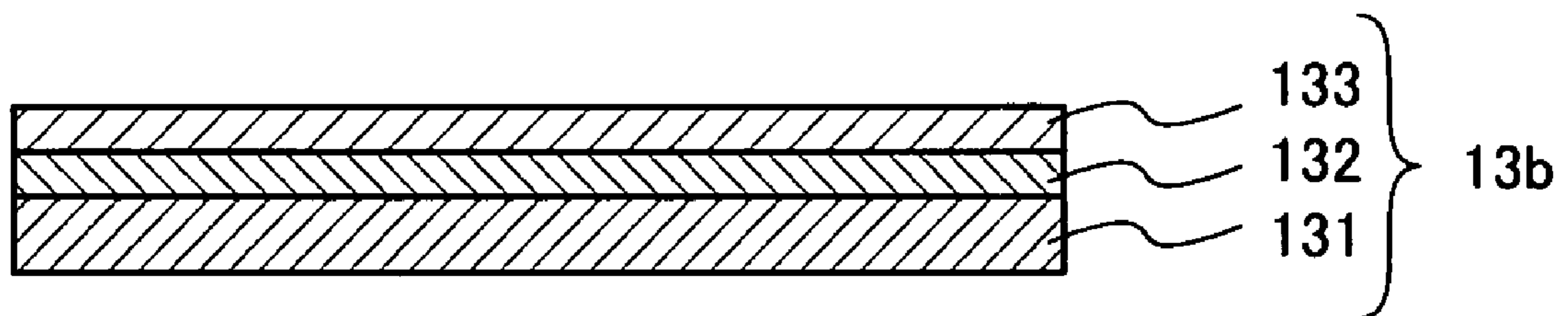


Fig.4
(RELATED ART)

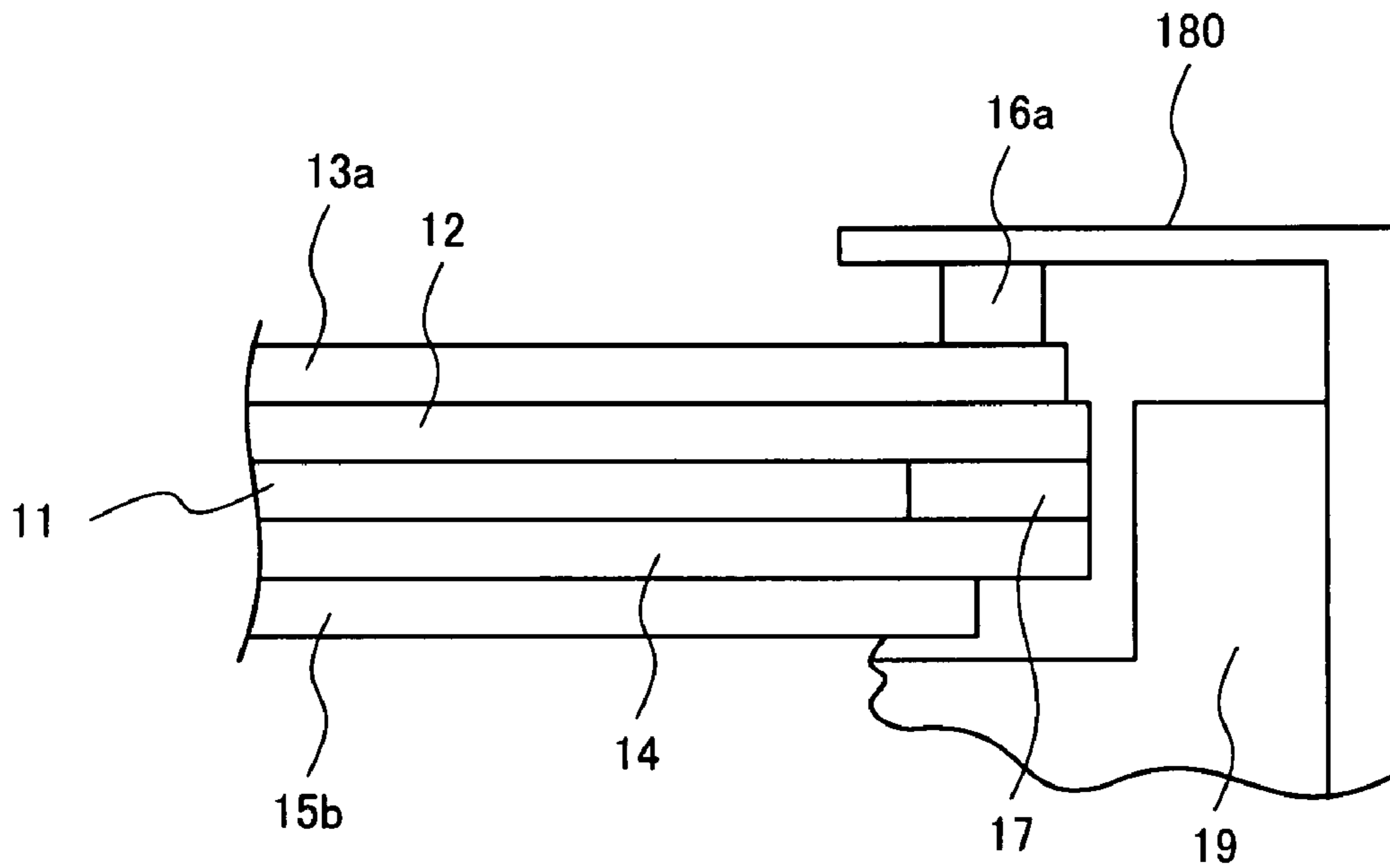


Fig.5
(RELATED ART)

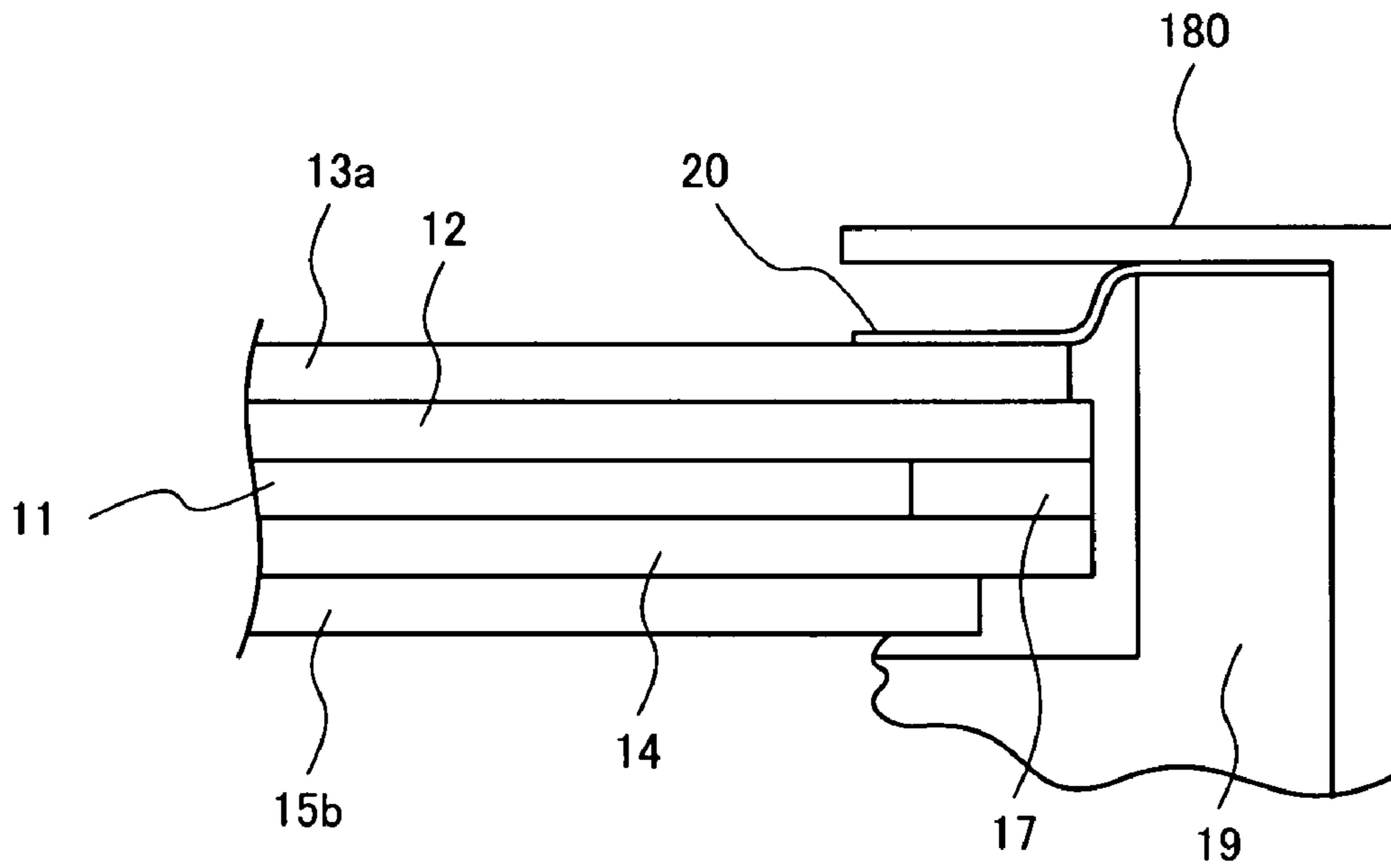


Fig.6
(RELATED ART)

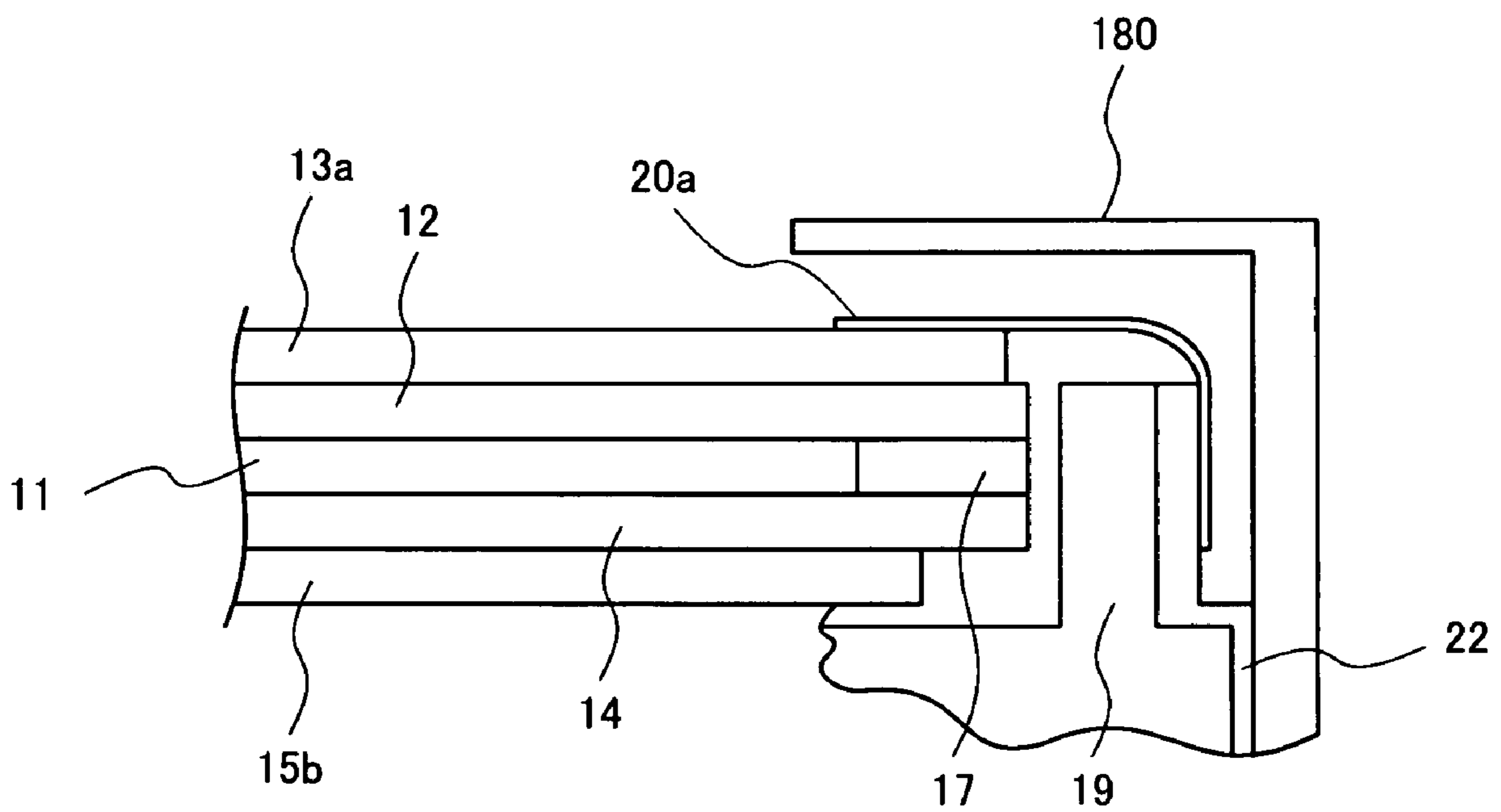


Fig.7
(RELATED ART)

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**LIQUID CRYSTAL DISPLAY APPARATUS
AND METHOD FOR GROUNDING LIQUID
CRYSTAL DISPLAY APPARATUS**

RELATED APPLICATIONS

This application is based upon and claims the benefit of priority from Japanese patent application No. 2006-262221, filed on Sep. 27, 2006, the disclosure of which is incorporated herein in its entirety by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a liquid crystal display apparatus and a method for grounding the liquid crystal display apparatus.

2. Description of the Related Art

Generally, a liquid crystal display apparatus includes a liquid crystal display panel, a backlight unit and a chassis (case). The backlight unit is arranged at a back face of the liquid crystal display panel. The liquid crystal display apparatus includes a structure in which the liquid crystal display panel integrated with the backlight unit is installed in a metallic frame (i.e. the chassis).

The liquid crystal display panel includes a liquid crystal driving circuit substrate, an opposite substrate, a sealing member and a liquid crystal material. The liquid crystal driving circuit substrate and the opposite substrate are oppositely arranged with a gap therebetween which is formed by the sealing member. The liquid crystal material is disposed in the gap to form the liquid crystal display panel. The liquid crystal driving circuit substrate includes a liquid crystal driving circuit on a surface thereof (the inner surface) which contacts the liquid crystal material.

Some opposite substrates of the liquid crystal display panels do not include a conductor on surfaces thereof. That is, such opposite substrate is not connected electrically anywhere and consequently, is in an electrically floating state. For example, a liquid crystal display apparatus of a normally black mode type according to IPS (In-Plane Switching) method includes the opposite substrate above mentioned.

A polarizing plate including a conductor on a surface thereof thereon is attached to a surface of the opposite substrate in the electrically floating state in order to discharge an electric charge (i.e. static electricity) on the opposite substrate. The opposite substrate is grounded (GND) when the conductor mounted on the surface of the polarizing plate contacts the metallic frame.

In such liquid crystal display panel, the polarizing plate at the opposite substrate side is smaller than an external shape of the liquid crystal display panel. Therefore, the conductor for grounding is pressed physically by the metallic frame against the polarizing plate arranged on a surface of the liquid crystal display panel. As a result, a stress is applied to the liquid crystal display panel, and consequently, the stress causes an uneven image on a screen.

Methods for grounding from the surface of the polarizing plate at the opposite substrate side according to a related art will be described in FIG. 3 to FIG. 7. Japanese Patent Application Laid-Open No. 2004-355035 (Japanese Patent Application No. 2004-270865) discloses a liquid crystal display apparatus having a structure for grounding the opposite substrate mentioned above. FIG. 3 is a cross sectional view showing the disclosed liquid crystal display apparatus. FIG. 4 is a cross sectional view showing a structure of the polarizing

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plate shown in FIG. 3. FIG. 5 is a fragmentary cross sectional view showing details of the liquid crystal display panel shown in FIG. 3.

The liquid crystal display apparatus shown in FIG. 3 includes a liquid crystal material **11**, an upper polarizing plate **13b**, a conductor **16a**, a metallic frame **180**, a lower polarizing plate **15a**, a backlight unit **19** and a printed wiring board **21**. The conductor **16a** includes, for example, a conductive rubber and forms electrical connection between the upper polarizing plate **13b** and the metallic frame **180**.

As shown in FIG. 4, the upper polarizing plate **13b** includes a three-layered structure having an optical polarizing layer **131**, a conductive layer **132** and an antireflection layer **133**. Both-sided adhesive tapes formed on both sides of the conductor **16a** bond the upper polarizing plate **13b** and the conductor **16a** and bond the metallic frame **180** and the conductor **16a**. The conductive layer **132** is, for example, an ITO (Indium Tin Oxide) film formed with the sputtering method. A film made of SiO₂ is formed as the antireflection layer **133** on the surface of the conductive layer **132** for protection thereof.

An opposite substrate **12** and an opposite substrate side polarizing plate **13a** shown in FIG. 5 correspond to the upper polarizing plate **13b** shown in FIG. 3. A liquid crystal driving circuit substrate **14** and a liquid crystal driving circuit side polarizing plate **15b** shown in FIG. 5 correspond to the lower polarizing plate **15a** shown in FIG. 3. The liquid crystal display panel has a structure that the liquid crystal driving circuit substrate **14** and the opposite substrate **12** are oppositely arranged with a predetermined gap and are sealed by a sealing member **17**. The liquid crystal material **11** is disposed in the gap therebetween. The polarizing plate **13a** at the opposite substrate side is adhered to a front surface (i.e. a display surface side) of the liquid crystal display panel. The polarizing plate **15a** at the liquid crystal driving circuit side is adhered to a rear surface of the liquid crystal display panel.

According to the structure shown in FIG. 5, when the metallic frame **180** presses the conductor **16a** against the polarizing plate **13a** at the opposite substrate side arranged on the surface of the liquid crystal display panel, an electrical grounding is secured. However, stress is applied to the liquid crystal display panel, and consequently, an uneven image on a screen due to the stress is generated. If the stress is made so small that the uneven images do not occur, the electric resistance between the polarizing plate **13a** at the surface of the opposite substrate side and the metallic frame **180** via the conductor **16a** becomes large. As a result, the electric charge can not be discharged sufficiently.

FIG. 6 is a fragmentary cross sectional view showing other liquid crystal display apparatus disclosed in Japanese Patent Application Laid-Open No. 2004-355035. According to the disclosed structure, the metallic frame **180** and the polarizing plate **13a** at the opposite substrate side are connected electrically each other through a conductive tape **20**, instead of the conductor **16a**. In this case, since the conductive tape **20** is adhered to the surface of the polarizing plate **13a** at the opposite substrate side, the electric charge can be discharged to the metallic frame **180** without the stress originated with the metallic frame **180** which is applied to the surface of the liquid crystal display panel. However, according to the structure, when the liquid crystal display panel and the backlight unit **19** are installed in the metallic frame **180**, it becomes necessary to perform a step for adhering the conductive tape **20** which is an extra process. As a result, production cost of the liquid crystal display apparatus increases due to the additive step in the assembly process of the apparatus.

FIG. 7 is a fragmentary cross sectional view showing further other liquid crystal display apparatus disclosed in Japa-

nese Patent Application Laid-Open No. 2004-355035. According to the apparatus, a conductive tape **20a** is used. Here, the conductive tape **20a** is adhered to a metal part **22** of the backlight unit **19** instead of the metallic frame **180**. Accordingly, the apparatus includes the same difficulty as the apparatus shown in FIG. **6**.

SUMMARY OF THE INVENTION

The present invention has been proposed in view of the above mentioned circumstances. The object of the present invention is to provide a liquid crystal display apparatus in which a stress is not applied to a liquid crystal display panel and an uneven image does not occur, even if a strong contact is made on a surface of a polarizing plate for connection to the ground, and to provide a method for grounding the liquid crystal display apparatus.

The present invention provides a liquid crystal display apparatus, including: a liquid crystal display panel; a polarizing plate which is processed to be conductive and is attached to a surface of the liquid crystal display panel; and a conductive frame, wherein the polarizing plate includes a projecting area which projects outward from the edge of the liquid crystal display panel, and wherein the conductive frame presses the projecting area of the polarizing plate in order to ground the polarizing plate.

Further, the present invention provides a method for grounding a liquid crystal display apparatus including a liquid crystal display panel, a polarizing plate which is processed to be conductive, and a conductive frame, the method, including: attaching the polarizing plate to a surface of the liquid crystal display panel so that the polarizing plate includes a projecting area which projects outward from the edge of the liquid crystal display panel; and grounding the polarizing plate through the conductive frame which presses a surface of the projecting area of the polarizing plate.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary features and advantages of the present invention will become apparent from the following detailed description when taken with the accompanying drawings in which:

FIG. **1** is a fragmentary cross sectional view showing a first exemplary embodiment of the present invention.

FIG. **2** is a fragmentary cross sectional view showing a second exemplary embodiment of the present invention.

FIG. **3** is a cross sectional view showing a related art of a liquid crystal display apparatus.

FIG. **4** is a cross sectional view showing a structure of the polarizing plate shown in FIG. **3**.

FIG. **5** is a fragmentary cross sectional view showing details of the liquid crystal display panel shown in FIG. **3**.

FIG. **6** is a fragmentary cross sectional view showing other related art of the liquid crystal display apparatus.

FIG. **7** is a fragmentary cross sectional view showing further other related art of the liquid crystal display apparatus.

DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

Exemplary embodiments of the present invention will now be described in detail in accordance with the accompanying drawings.

(First Exemplary Embodiment)

FIG. **1** is a cross sectional view of a part of a liquid crystal display apparatus according to a first exemplary embodiment

of the present invention. As shown in FIG. **1**, the liquid crystal display apparatus according to the embodiment includes a liquid crystal material **11**, an opposite substrate **12**, a polarizing plate **13** at an opposite substrate side, a liquid crystal driving circuit substrate **14**, a polarizing plate **15** at a liquid crystal driving circuit side, a conductor **16**, a sealing member **17**, a metallic frame **18** and a backlight unit **19**.

The liquid crystal driving circuit substrate **14** and the opposite substrate **12** are oppositely disposed each other by the sealing member **17** so that a gap is formed therebetween. The liquid crystal material **11** is put into the gap to form the liquid crystal display panel. A liquid crystal driving circuit is mounted on an inner surface of the liquid crystal driving circuit substrate **14**, which contacts the liquid crystal material **11**. The opposite substrate **12** does not include a conductive layer over a surface thereof and then is electrically floated. Since the opposite substrate **12** tends to be influenced by an electric charge (i.e. static electricity), the polarizing plate **13** at the opposite substrate side whose surface includes a conductive layer is attached or adhered to an outer surface of the opposite substrate **12**.

In the exemplary embodiment, the polarizing plate **13** at the opposite substrate side is larger than an external shape of the liquid crystal display panel (that is, the size of the external shape of the opposite substrate **12** and the liquid crystal driving circuit substrate **14**). That is, when the polarizing plate **13** at the opposite substrate side is attached or adhered to a surface of the opposite substrate **12**, a part of the polarizing plate **13** projects outward from the edge of the liquid crystal display panel (i.e., a projecting area). Moreover, the surface of the projecting area of the polarizing plate **13**, which is processed to be conductive, is electrically connected to the metallic frame **18** via the conductor **16**. As a result, the opposite substrate **12** is grounded (GND) via the metallic frame **18** and an electric charge thereon are discharged. Further, the polarizing plate **15** at the liquid crystal driving circuit side is attached to an outer surface of the liquid crystal driving circuit substrate **14**.

The exemplary embodiment includes following features compared with the related art shown in FIG. **3** to FIG. **7**.

(1) the polarizing plate **13** at the opposite substrate side includes a part or area which projects outward from the edge of the external shape of the liquid crystal display panel.

(2) the electric connection to the ground is secured through the projecting area or part of the polarizing plate **13** which is pressed physically via the conductor **16** by the metallic frame **18**.

There are many methods to connect electrically to the surface of the polarizing plate **13** at the opposite substrate side for grounding. However, when the conductor **16** is pressed to the polarizing plate **13**, the stress due to the press is applied to the opposite substrate **12** which is one of elements of the display panel. Consequently, uneven image is generated on a screen. In particular, in the liquid crystal display apparatus of a normally black mode type according to IPS (In-Plane Switching) method, a white spot as unevenness occurs on a black screen. The unevenness on a screen may be generated by a small stress. If the stress to the polarizing plate **13** at the opposite substrate side is reduced in order to avoid generation of the unevenness on a screen, the electric connection to the ground becomes insufficient.

According to the exemplary embodiment, a part of the polarizing plate **13** at the opposite substrate side projects outward from the edge of the liquid crystal display panel. Moreover, the conductor **16** for grounding presses the projecting area of the polarizing plate **13** which is located on an upper part of the backlight unit **19**. Accordingly, although the

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stress is applied to the projecting area of the polarizing plate **13** at the opposite substrate side, the stress is not applied to the screen (i.e. the opposite substrate **12**) of the liquid crystal display panel. Accordingly, it is possible to display an excellent image without the unevenness, since the liquid crystal display panel is free from stress and the electric connection for grounding can be secured sufficiently.

Next, a method for manufacturing the liquid crystal display apparatus shown in FIG. **1** will be described. First, the liquid crystal driving circuit substrate **14** and the opposite substrate **12** are oppositely disposed, via the sealing member **17**, with a predetermined gap therebetween. The gap is filled with the liquid crystal material **11** and is sealed by the sealing member **17** to form the liquid crystal display panel. Next, the polarizing plate **13** is attached to an outer surface of the opposite substrate **12** in the display panel. Also, the polarizing plate **15** is attached to an outer surface of the liquid crystal driving circuit substrate **14**. An outer surface of the polarizing plate **13**, which does not contact the opposite substrate **12**, is processed to be conductive so that an electric charge on the display panel can be discharged. The process for forming conductivity may include a method of vapor deposition of conductor, such as transparent metal, on the polarizing plate **13**, and a method of applying transparent resin including metallic fillers to the polarizing plate **13**.

When the liquid crystal display apparatus is assembled, the conductor **16** is mounted on the metallic frame **18** so that the conductor **16** can connect the conductive projecting area of the polarizing plate **13**. The polarizing plate **13** and the metallic frame **18** are electrically connected and fixed each other via the conductor **16**, for example, with a double-faced adhesive tape, an adhesive or the like, each of which is electrically conductive. As a result, electric connection between the polarizing plate **13** and the metallic frame **18** which is connected to the ground (GND) can be secured. The metallic frame **18** can be made of metal such as stainless steel. The conductor **16** can be metallic spring, electrically conductive rubber or the like. Further, the metallic frame **18** may be made of material other than metal. That is, a conductive frame whose conductivity can secure the electric connection to the ground may be employed as the substitution of the metallic frame **18**.

(Second Exemplary Embodiment)

Next, a second exemplary embodiment of the present invention will be described with reference to drawings. FIG. **2** is a cross sectional view of a part of a liquid crystal display apparatus' according to the second exemplary embodiment of the present invention. The conductor **16** shown in FIG. **1** is not used in FIG. **2**. In FIG. **2**, a metallic frame **18a** includes an elastic contact part **18b** which is formed to be convex toward the projecting area of the polarizing plate **13** through processing the metallic frame **18a**. The contact part **18b** touches and presses the projecting area of the polarizing plate **13** to make electric contact therewith. The contact part **18b** of the metallic frame **18a** can be processed with various methods such as bending work and press work.

Electric connection between the metallic frame **18a** and the polarizing plate **13** can be formed by strong contact between the contact part **18b** and the projecting area of the polarizing plate **13**. Moreover, uneven image on a screen due to stress applied to the liquid crystal display panel is not generated, because the stress is not applied to the panel. Further, the metallic frame **18a** according to the exemplary embodiment may be made of a conductive frame other than metal. A number of components and cost thereof can be reduced in the

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second embodiment, compared with the first embodiment, since it is unnecessary to use the conductor **16** mounted on the metallic frame **18a**.

As described above, according to the exemplary embodiments of the present invention, the part of the polarizing plate which is adhered to the surface of the liquid crystal display panel projects outward from the external shape of the display panel. The projecting area of the polarizing plate **13** is pressed from the conductive frame to make electric contact for grounding. Therefore, uneven image on a screen is not generated, since no stress is applied to the liquid crystal display panel even though the conductive frame strongly presses the polarizing plate to make electric contact for grounding.

The previous description of embodiments is provided to enable a person skilled in the art to make and use the present invention. Moreover, various modifications to these embodiments will be readily apparent to those skilled in the art, and the generic principles and specific examples defined herein may be applied to other embodiments without the use of inventive faculty. Therefore, the present invention is not intended to be limited to the embodiments described herein but is to be accorded the widest scope as defined by the limitations of the claims and equivalents.

Further, it is noted that the inventor's intent is to retain all equivalents of the claimed invention even if the claims are amended during prosecution.

What is claimed is:

1. A liquid crystal display apparatus, comprising:
 - a liquid crystal display panel, comprising:
 - a liquid crystal driving circuit;
 - a sealing member and a liquid crystal material disposed on an upper surface of the liquid crystal driving circuit; and
 - an opposite substrate disposed on an upper surface of the sealing member and an upper surface of the liquid crystal material;
 - a polarizing plate which is conductive and is attached to an upper surface of the liquid crystal display panel; and
 - a conductive frame,
 - wherein the polarizing plate includes a projecting area which projects outward from an edge of the opposite substrate in a direction of extension of the liquid crystal display panel,
 - wherein the conductive frame comprises an opposing part located opposite to the projecting area of the polarizing plate,
 - wherein the opposing part of the conductive frame applies a pressure directly or indirectly to the projecting area of the polarizing plate in order to ground the polarizing plate, and
 - wherein a position at which the opposing part of the conductive frame applies the pressure to the projecting area of the polarizing plate is located outside the edge of the opposite substrate.
2. The liquid crystal display apparatus according to claim 1, wherein the opposite substrate is in an electrically floating state before the polarizing plate is attached.
3. The liquid crystal display apparatus according to claim 2, wherein the liquid crystal driving circuit and the opposite substrate are attached to opposite sides of the liquid crystal material.
4. The liquid crystal display apparatus according to claim 1, wherein the polarizing plate is grounded through a conductor for grounding which is disposed between the conductive frame and a surface of the polarizing plate.

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5. The liquid crystal display apparatus according to claim 4, wherein the conductor for grounding comprises a conductive rubber.

6. The liquid crystal display apparatus according to claim 1, wherein the conductive frame comprises a metallic frame.

7. A method for grounding a liquid crystal display apparatus including a liquid crystal display panel, a polarizing plate which is processed to be conductive, and a conductive frame, the liquid crystal display panel comprising:

a liquid crystal driving circuit;

a sealing member and a liquid crystal material disposed on an upper surface of the liquid crystal driving circuit; and an opposite substrate disposed on an upper surface of the sealing member and an upper surface of the liquid crystal material, the method comprising:

attaching the polarizing plate to an upper surface of the liquid crystal display panel so that the polarizing plate includes a projecting area which projects outward from an edge of the opposite substrate in a direction of extension of the liquid crystal display panel,

wherein the conductive frame comprises an opposing part located opposite to the projecting area of the polarizing plate; and

grounding the polarizing plate through the opposing part of the conductive frame which applies a pressure directly or indirectly to a surface of the projecting area of the polarizing plate,

wherein a position at which the opposing part of the conductive frame applies the pressure to the projecting area of the polarizing plate is located outside the edge of the opposite substrate.

8. The method for grounding the liquid crystal display apparatus according to claim 7, wherein the opposite substrate is in an electrically floating state.

9. The method for grounding the liquid crystal display apparatus according to claim 8, wherein the liquid crystal driving circuit and the opposite substrate are attached to opposite sides of the liquid crystal material.

10. The method for grounding the liquid crystal display apparatus according to claim 7, wherein the polarizing plate is grounded through a conductor for grounding which is disposed between the conductive frame and a surface of the polarizing plate.

11. The method for grounding the liquid crystal display apparatus according to claim 10, wherein the conductor for grounding comprises a conductive rubber.

12. The method for grounding the liquid crystal display apparatus according to claim 7, wherein the conductive frame comprises a metallic frame,

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13. The liquid crystal display apparatus according to claim 1, wherein the projecting area is placed outside an overlapping area between the polarization plate and the liquid crystal display panel, said overlapping area, in a plan view, extending perpendicular to the direction of extension of the liquid crystal display panel, and

wherein an area, through which the conductive frame presses the polarization plate, is confined within the projection area.

14. The liquid crystal display apparatus according to claim 1, wherein the projecting area of the polarizing plate has a stress applied thereto and a screen of the liquid crystal display panel is devoid of said stress.

15. The liquid crystal display apparatus according to claim 4, wherein the conductor for grounding is completely placed outside an overlapping area between the polarization plate and the liquid crystal display panel, said overlapping area, in a plan view, extending perpendicular to the direction of extension of the liquid crystal display panel

16. The method for grounding the liquid crystal display apparatus according to claim 7, wherein the projecting area is placed outside an overlapping area between the polarization plate and the liquid crystal display panel, said overlapping area, in a plan view, extending perpendicular to the direction of extension of the liquid crystal display panel, and

wherein an area, through which the conductive frame presses the surface of the polarization plate, is confined within the projecting area.

17. The liquid crystal display apparatus according to claim 7, wherein the projecting area of the polarizing plate has a stress applied thereto and a screen of the liquid crystal display panel is devoid of said stress.

18. The method for grounding the liquid crystal display apparatus according to claim 10, wherein the conductor for grounding is completely placed outside an overlapping area between the polarization plate and the liquid crystal display panel, said overlapping area, in a plan view, extending perpendicular to the direction of extension of the liquid crystal display panel.

19. The liquid crystal display apparatus according to claim 1, wherein a direction, in which the opposing part of the conductive frame applies the pressure to the projecting area of the polarizing plate, is approximately perpendicular to the direction of extension of the liquid crystal display panel.

20. The liquid crystal display apparatus according to claim 1, wherein the sealing member abuts the upper surface of the liquid crystal driving circuit, a side surface of the liquid crystal material, and a bottom surface of the opposite substrate.

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